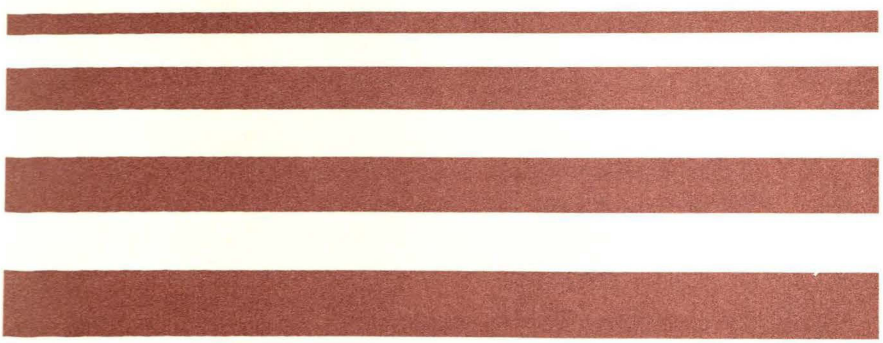
USDA FOREST SERVICE
RESOURCE BULLETIN NC-40

Land-Use Change in Missouri, 1959-1972

Pamela J. Jakes
John S. Spencer, Jr.
Burton L. Essex



...Central Forest Experiment Station
...orest Service, U.S. Department of Agriculture

North Central Forest Experiment Station
Robert A. Hann, Director
Forest Service—U.S. Department of Agriculture
1992 Folwell Avenue
St. Paul, Minnesota 55108

Manuscript approved for publication December 14, 1978
1979

LAND-USE CHANGE IN MISSOURI, 1959-1972

Pamela J. Jakes, *Associate Resource Analyst,*
John S. Spencer, Jr., *Resource Analyst,*
and **Burton L. Essex,** *Principal Resource Analyst*

Between 1959 and 1972, the area of commercial forest land[1] in Missouri declined 11 percent. This decline has caused concern among citizens of the State who question the wisdom of converting large areas of commercial forest land to nonforest uses. This concern frequently focuses on the following questions:

1. What is the magnitude and direction of land-use change in Missouri?
2. Which areas of the State have been most affected by land-use change?
3. What is the site quality of areas removed from the commercial forest land base?
4. Which forest types have been affected by land-use change?
5. What happened to lands that remained commercial forest land between 1959 and 1972?

By analyzing data collected from remeasurement of permanent sample plots during Missouri's third Forest Survey (1972)[2], and comparing this data to that collected on the same plots from Missouri's second Forest Survey (1959), these questions can be answered.

[1]*Commercial forest land is forest land that is producing or is capable of producing crops of industrial wood, and that is not withdrawn from timber utilization by statute or administrative regulation. Other terms are defined in the Appendix.*

[2]*Additional information from Missouri's third Forest Survey is published in the State Report, Timber in Missouri, 1972 (Resource Bulletin NC-30), and five Survey Unit reports, Timber Resource of Missouri's Eastern Ozarks (Resource Bulletin NC-19), Timber Resource of Missouri's Southwestern Ozarks (Resource Bulletin NC-21), Timber Resource of Missouri's Northwestern Ozarks (Resource Bulletin NC-22), Timber Resource of Missouri's Prairie Region (Resource Bulletin NC-26), and Timber Resource of Missouri's Riverborder Region (Resource Bulletin NC-25).*

WHAT IS THE MAGNITUDE AND DIRECTION OF LAND-USE CHANGE IN MISSOURI BETWEEN 1959 AND 1972?

Most shifts in land use are the result of man-initiated actions. Forests are cleared, homes are built, crops are planted, wetlands are drained, and legislative action transfers commercial forest land to productive-reserved status. In a few cases, land use changes occur naturally. Forest encroaches on abandoned farmland as tree stocking increases, so the land is placed in one of the forest land use categories.

Shifts in land use in Missouri between 1959 and 1972 occurred among all three land classes. Changes in land use resulted in an 11 percent reduction in the area of commercial forest land, a 4 percent increase in the area of nonforest land, and a 24 percent increase in the area of noncommercial forest land (table 1).

Table 1.—*Area of land by land class, Missouri 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	13,818.3	12,364.7	−10.5
noncommercial forest			
productive-reserved	90.3	256.1	+183.6
unproductive	357.8	298.3	−16.6
subtotal	14,266.4	12,919.1	−9.4
Nonforest land	30,038.2	31,270.2	+4.1
Total land	44,304.6	44,189.3	−0.3

Commercial Forest Area Declines

Of the 13.8 million acres of land classified as commercial forest in 1959, 1.7 million acres were converted to nonforest uses by 1972 (table 13, Appendix).

Commercial forest acreage was converted to nonforest uses between 1959 and 1972 as follows:

Nonforest land use	Area
	(acres)
Pasture	1,332,100
Cropland	230,000
Rights-of-way	84,800
Urban	36,400
Recreation	33,100
Other	30,400
Total	1,746,800

Most of the commercial forest land was converted to pasture; more than 72 percent of the new pasture is classified as wooded pasture. This land is sufficiently stocked with trees to be classed as forest land, but the present highest use is forage production for livestock. If, in the future, livestock were removed from the land, it would be reclassified as forest land.

Herbicides were used to convert 166,200 acres of commercial forest land to pasture. The remaining 1.2 million acres of new pasture were created by simply changing land use (as in the case of wooded pasture) or by altering cover vegetation through cutting, burning or bulldozing.

The volume of growing stock on the land converted to nonforest uses was 626.6 million cubic feet in 1959. If this land had remained in timber production, and if the volume had increased at the same rate as the remaining forest stands in the State (0.4 percent of inventory volume per year); there would have been an additional 657.8 million cubic feet of growing-stock inventory in 1972. This additional volume would increase the reported 1972 inventory volume by 11 percent. Furthermore, if timber removals from the converted land had occurred at the same rate as removals in 1972 (3 percent of inventory), removals for 1972 would have increased by 19.7 million cubic feet (12 percent).

Between 1959 and 1972, 391,200 acres of nonforest land were returned to commercial forest land through natural regeneration of forest trees. Much of the natural regeneration occurred on land classified as cropland or pasture in 1959 but which became sufficiently stocked with trees by 1972 to be classified as commercial forest land. The increase in growing-stock volume on commercial forest land due to the addition of nonforest land to the forest land base is slight—about 38 million cubic feet. One reason for the low volume increase is that the trees on the new commercial forest land are primarily seedlings and saplings, representing no inventory volume. The removal of land from the commercial forest base causes an immediate reduction in available merchantable wood volume, while increases in commercial forest acreage may not produce merchantable volumes for 20 to 30 years. A second reason for low volume on land reverting to forest is that 30 percent of this new commercial forest land is classified as nonstocked, with stocking of trees less than 16.7 percent.

An additional 67,800 acres of commercial forest land were found on sites classified as unproductive in 1959. Most of this increase in commercial forest is the result of formerly unproductive land being drained sufficiently by 1972 to be reclassified. Sixty-one percent of this change occurred in the Northwestern Ozarks.

As a result of these changes in land use, commercial forest area declined from 13.8 million acres in 1959 to 12.4 million acres in 1972.

Noncommercial Forest Areas Increase by 24 Percent

The area of noncommercial forest land increased from 448,100 acres in 1959 to 554,400 acres in 1972 (table 14). This increase was the result of commercial forest land being placed under productive-reserved status (165,800 acres) and nonforest land reverting to unproductive forest (29,000 acres).

Nonforest Land Increases in Area by 4 Percent

The area of nonforest land increased in Missouri from 30.0 million acres in 1959 to 31.3 million acres in 1972. The increase in nonforest area was due primarily to commercial forest land being converted to nonforest uses (as discussed in detail above), however, additional increases in nonforest area were the result of unproductive forest land being converted to urban uses (7,200 acres) and pasture (13,500 acres).

WHICH AREAS OF THE STATE HAVE BEEN MOST AFFECTED BY LAND USE CHANGE?

Commercial forests do not occur uniformly across Missouri, but vary by Forest Survey Unit (fig. 1). One-third of the commercial forest land in the State lies in the Eastern Ozarks which contains only 14 percent of the total land area of the State (fig. 2). The three Ozark units together account for 67 percent of the total commercial forest land in Missouri. The Northern Prairie Unit contains 37 percent of the nonforest acreage (most of which is cropland), and the Southern Prairie Unit includes the next largest percentage of nonforest land (19 percent). Just as the forest area varies by region, land-use change also varied.

The Missouri Ozarks

Unit 1–Eastern Ozarks

The Eastern Ozarks Unit is an important source of wood fiber for Missouri's forest products industries. In 1969, the Eastern Ozarks supplied one-half of the total saw log volume harvested in the State and one-fourth of the total cooperage volume harvested[3]. The Unit contains a large portion of the State's commercially valuable oak types. Over 42 percent of the State's black-scarlet oak acreage occurs in the region as does 32 percent of the white oak area. Shifts in land use are of importance

[3]*Blyth, James E., and Robert Massengale. 1972. Missouri's primary forest products output and industries 1969. U.S. Dep. Agric. For. Serv., Resour. Bull. NC-16, 15 p. North Cent. For. Exp. Stn., St. Paul, Minnesota.*

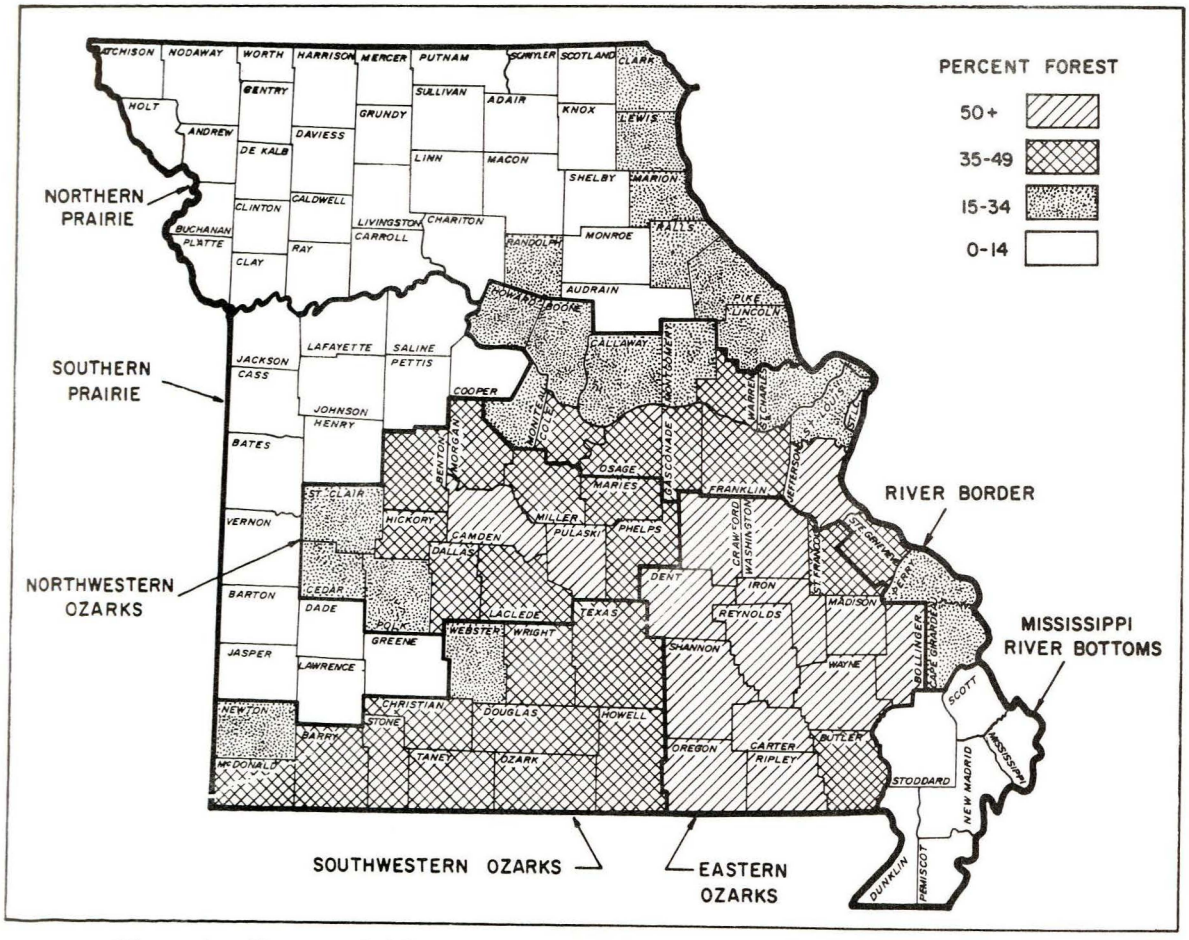


Figure 1.—*Commercial forest area as a percent of land area, by county, Missouri, 1972.*

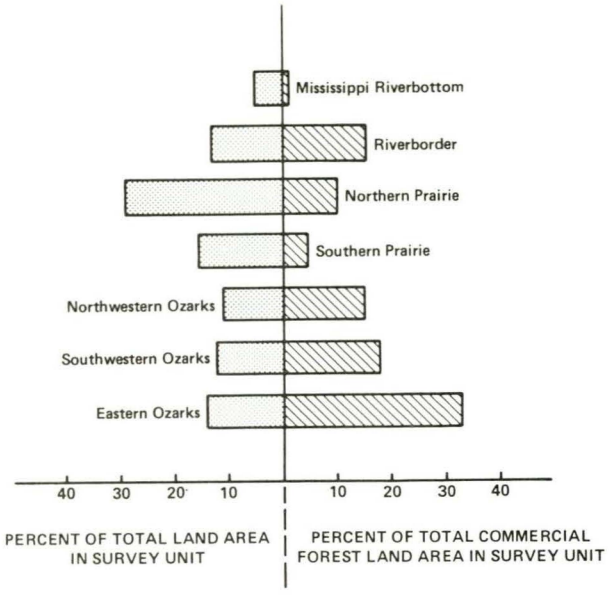


Figure 2.—*Distribution of total land area and commercial forest area among Survey Units, Missouri, 1972.*

because of the possible effects these shifts may have on future timber supplies (table 2). Of the 4.3 million acres of commercial forest in the Unit in 1959, 286,100 acres were converted to other uses by 1972 (table 15, Appendix). The largest amount of commercial forest was lost to pasture by means other than herbicide application (111,600 acres). Many commercial forest acres (70,800 acres) were also placed under productive-reserved status. The 24,000 acres of commercial forest converted to rights-of-way in the Unit is 28 percent of the State total.

Table 2.—*Area by land class, Eastern Ozarks Unit, Missouri, 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	4,259.4	4,084.0	−4.1
noncommercial forest			
productive-reserved	26.5	97.3	+267.2
unproductive	71.9	63.3	−12.0
subtotal	4,357.8	4,244.6	−2.6
Nonforest land	1,792.0	1,918.3	+7.0
Total land	6,149.8	6,162.9	+0.2

The growing-stock volume on land converted to nonforest uses was 87 million cubic feet in 1959. If this volume had grown at the same rate as the State average between 1959 and 1972, it would represent 91.3 million cubic feet in 1972. As with area, most of the volume loss occurred on land converted to pasture by means other than herbicides (45 million cubic feet).

Areas returned to commercial forest land from noncommercial forest land by physiographic changes (16,300 acres), and from nonforest land by natural reversion (94,400 acres) were not enough to offset shifts from commercial forest land to other uses, resulting in a net decrease of 175,400 acres in commercial forest land.

Further shifts in land use in the Eastern Ozarks resulted in an increase in the area of noncommercial forest land and nonforest land. From 1959 to 1972 the area of noncommercial forest land increased 62,200 thousand acres while the area of nonforest land increased 126,300 acres. Most of the noncommercial forest land increase occurred in productive-reserved, the largest increase among nonforest land uses occurred in pasture.

Unit 2–Southwestern Ozarks

The area of commercial forest land in the Southwestern Ozarks declined 504,000 acres between surveys, from 2.8 million acres in 1959 to 2.3 million acres in 1972 (table 3). The Unit lost more acreage from its commercial forest base than any other Unit. This decline in commercial forest acreage is important not only because of the magnitude of the change, but also because the loss occurred in a Unit that is a major source of wood fiber for Missouri's wood products industries. In 1969, one-fifth of the total saw log volume harvested in the State came from this area.[3]

Of the 2.8 million acres of commercial forest land reported in the Southwestern Ozarks in 1959, 557,100 acres (20 percent) were converted to other uses by 1972 (table 16, Appendix). There were 133.3 million cubic feet of growing-stock inventory on the converted land in 1959. By projecting the 1959 volume to 1972 using the average annual increase in volume for that period, the 133.3 mil-

Table 3.—*Area by land class, Southwestern Ozarks Unit, Missouri, 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	2,815.4	2,311.4	−17.9
noncommercial forest			
productive-reserved	17.6	22.6	+28.4
unproductive	121.2	109.3	−9.8
subtotal	2,954.2	2,443.3	−17.3
Nonforest land	2,573.5	2,997.0	+16.5
Total land	5,527.7	5,440.3	−1.6

Table 4.—*Area by land class, Northwestern Ozarks Unit, Missouri, 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	2,146.3	1,920.0	−10.5
noncommercial forest			
productive-reserved	14.7	73.6	+400.7
unproductive	116.6	77.4	−33.6
subtotal	2,277.6	2,071.0	−9.1
Nonforest land	2,780.9	2,958.5	+6.4
Total land	5,058.5	5,029.5	−0.6

lion cubic feet grows to 139.9 million cubic feet. This additional inventory would have resulted in a 16 percent increase in the Unit's 1972 growing stock volume.

Most of the commercial forest land lost to other uses was converted to pasture. Of the total Missouri commercial forest land acreage converted to pasture between surveys, one-third was converted in the Southwestern Ozarks. The remaining 43,800 acres of commerical forest land converted to other uses between surveys went to rights-of-way, cropland, urban development, productive-reserved, and other uses.

Noncommercial and nonforest lands changed to commercial forest land as a result of physiographic change and natural reversion. These additions to the commercial forest land base were offset by the diversion of commercial forest land to other uses (mentioned above), resulting in a net loss of 504,000 acres of commercial forest land.

The area of noncommercial forest land in the Southwestern Ozarks decreased from 138,800 acres in 1959 to 131,900 acres in 1972. Nonforest land area increased from 2.6 million acres in 1959 to 3.0 million acres in 1972, mainly from increases in the area of pasture.

Unit 3–Northwestern Ozarks

Fifteen percent of the 2.1 million acres of commercial forest land in the Northwestern Ozarks in 1959 was converted to nonforest or noncommercial forest uses by 1972 (table 4). In 1959, 70.2 million cubic feet of growing stock trees occupied forest land that was later converted to other uses. This volume would have grown to an estimated 73.7 million cubic feet by 1972, increasing the Unit's growing stock inventory in that year by 11 percent (table 17, Appendix).

Again, the creation of pasture accounted for the largest percentage of commercial forest land lost in the Unit between surveys; 260,400 acres of land previously classified as commercial forest land were converted to pasture by 1972. The Northwestern Ozarks accounted for over 40 percent of the total commercial forest land converted to pasture through the use of herbicides in the State.

The area of noncommercial forest land in the Northwestern Ozarks increased from 131,300 acres in 1959 to 151,000 acres in 1972. This increase was brought about by the transfer of commercial forest land to productive-reserved, and the reversion of nonforest land to unproductive forest land. The area of nonforest land also increased between surveys, from 2.8 million acres to 3.0 million acres.

The Prairie Units

Unit 4–Southern Prairie Unit

In 1959 there were 742,300 acres of commercial forest land in Missouri's Southern Prairie Unit; by 1972 this area had been reduced to 621,100 acres (table 5). Growing-stock volume on the 158,100 acres of forest land converted to other uses totaled 39.1 million cubic feet in 1959, and could have grown to 41.1 million cubic feet in 1972. Over 20 percent of the area classified as commercial forest land in 1959 was reclassified as pasture, productive-reserved and cropland (table 18, Appendix).

Table 5.—*Area by land class, Southern Prairie Unit, Missouri, 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	742.3	621.1	−16.3
noncommercial forest			
productive-reserved	3.7	34.8	+840.5
unproductive	4.5	4.5	0
subtotal	750.5	660.4	−12.0
Nonforest land	5,786.5	5,872.4	+1.5
Total land	6,537.0	6,532.8	−0.1

Table 6.—*Area by land class, Northern Prairie Unit, Missouri, 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	1,666.5	1,319.3	−20.8
noncommercial forest			
productive-reserved	11.7	11.7	0
unproductive	11.4	11.4	0
subtotal	1,689.6	1,342.4	−20.5
Nonforest land	11,330.5	11,673.1	+3.0
Total land	13,020.1	13,015.5	(1)

[1]Less than 0.1 percent.

Acreage converted to commercial forest land in the Southern Prairies by natural reversion of nonforest land was not enough to offset losses from the commercial forest land base, resulting in a net decrease of 121,200 acres in commercial forest.

The area of noncommercial forest land increased 31,100 acres from 1959 to 1972; the increase resulting from commercial forest land being transferred to productive-reserved. Nonforest land area increased from 5.8 million acres in 1959 to 5.9 million acres in 1972.

Unit 5–Northern Prairie

The conversion of 364,200 acres of commercial forest land to nonforest uses in the Northern Prairie accounted for one-fifth of the total change from commercial forest to nonforest in Missouri between surveys (table 6). Commercial forest land was diverted to pasture, cropland, rights-of-way, urban development, and recreational areas. Commercial forest land converted to urban uses in the Northern Prairie made up 42 percent of the State total; commercial forest land transferred to recreational uses accounted for 46 percent of the State total (table 19, Appendix).

The growing-stock inventory on the converted forest land totaled 176.6 million cubic feet in 1959. This volume loss due to land use change was the largest of any unit. If the trees had been left to grow, by 1972 the volume would have increased to an estimated 185.3 million cubic feet.

The small addition to the commercial forest land base through natural reversion of nonforest land did not balance the shifts from commercial forest land to nonforest uses, resulting in a net decrease in the commercial forest land area from 1959 to 1972 of 347,200 acres.

The acreage of noncommercial forest land remained unchanged (23,100 acres) in Unit 5 from 1959 to 1972. The nonforest land area increased in the Northern Prairie from 11.3 million acres in 1959 to 11.7 million acres in 1972.

The River Units

Unit 6–Riverborder Unit

The area of commercial forest land in the Riverborder Unit increased 8,600 acres between 1959 and 1972 (table 7). The entire increase was the result of the natural reversion of nonforest land to commercial forest (table 20, Appendix). This was the only Unit to show an increase in commercial forest area and consequent decrease in nonforest area. The area of noncommercial forest land increased from 47,400 acres in 1959 to 47,600 in 1972.

The Riverborder Unit is of importance to Missouri forestry concerns because in 1969 the Region supplied 40 percent of the total cooperage volume harvested in the State[3]. The Riverborder Unit also boasts a large portion of Missouri's forest types that are commercially important or are vital to the State's wildlife as habitat. Over 67 percent of the State's total eastern redcedar acreage occurs in the Unit as does 63 percent of the cottonwood acreage, 40 percent of the maple-beech acreage and 26 percent of the white oak acreage.

Table 7.—*Area by land class, Riverborder Unit, Missouri, 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	1,975.9	1,984.5	+0.4
noncommercial forest			
productive-reserved	15.2	15.2	0
unproductive	32.2	32.4	+0.6
subtotal	2,023.3	2,032.1	+0.4
Nonforest land	3,827.6	3,816.5	−0.3
Total land	5,850.9	5,848.6	(1)

[1]Less than 0.1 percent.

Table 8.—*Area by land class, Mississippi Riverbottom Unit, Missouri, 1959 and 1972*
(In thousand acres)

Land class	1959	1972	Percent change
Forest land			
commercial forest	212.5	124.4	−41.4
noncommercial forest			
productive-reserved	0.9	0.9	0
unproductive	—	—	—
subtotal	213.4	125.3	−41.3
Nonforest land	1,947.2	2,034.4	+4.5
Total land	2,160.6	2,159.7	(1)

[1]Less than 0.1 percent.

Unit 7–Mississippi Riverbottom Unit

The Mississippi Riverbottom Unit has the smallest acreage of commercial forest land in Missouri—124,400 acres in 1972—only 1 percent of the State's total. Forest type composition of the Unit includes cottonwood (38 percent of the State's total) oak-gum-cypress (14 percent), elm-ash-cottonwood (7 percent) and small amounts of maple-beech and oak types.

Of the 212,500 acres of commercial forest land in the Unit in 1959, 93,100 acres were reclassified as nonforest in 1972 (table 8). In 1959 there were 61.5 million cubic feet of growing-stock inventory on this land, by 1972 this volume could have grown to an estimated 64.6 million cubic feet. Commercial forest land in the Mississippi Riverbottom was converted primarily to cropland and pasture. Most of the new cropland was placed in soybean production (table 21, Appendix).

New acreage was added to the commercial forest base through natural reversion of nonforest land; however, shifts from commerical forest land to nonforest resulted in a net loss of 88,100 acres of commercial forest from 1959 to 1972.

The area of noncommercial forest land remained essentially unchanged from 1959 to 1972. Nonforest land increased from 1.9 million acres in 1959 to 2.0 million acres in 1972.

WHAT IS THE SITE QUALITY OF AREAS REMOVED FROM THE COMMERCIAL FOREST LAND BASE?

Knowledge of which sites are being removed from the commercial forest base is necessary for responsible land-use planning and forest management. For example, if commercial forest land being transferred to other uses is of poor quality, it may be socially and/or economically desirable to encourage this shift in land use. However, if sites with high productive potential are being removed from timber production, the transfer of commercial forest land to other uses may have a detrimental effect on future timber supplies and the State's forest products industries. In this case, policy makers may wish to take steps to discourage the diversion of high-site quality forest land.

The average volume per acre on commercial forest land converted to nonforest uses was 327.6 cubic feet in 1959. This volume is lower than the average volume per acre on all commercial forest land in that year (414 cubic feet). In order to analyze the site quality of commercial forest land converted to other uses, it was necessary to use site quality classes defined in the 1959 Forest Survey. At that time, forest site quality classes of excellent, good, medium and poor were defined by the number of logs produced by the dominant tree species on a site (table 9). These site quality classes

Table 9.—*Site quality classes used in Missouri's second Forest Survey, 1959*

Site class	Number of 16-foot logs			Generalized site conditions
	Hardwoods	Pine	Cedar	
Poor	1-1½	1-1½	1	Usually found on south and west slopes, upper parts of ridges, and on dry flats.
Medium	2-2½	3-3½	1	Usually found on north and west slopes, moist flats, and bottoms.
Good	3-3½	4-4½	2	Usually found in coves and bottomlands.
Excellent	4+	5+	2½+	

estimate the potential of a site for timber production and do not directly assess the potential of a site for producing other forest resources such as wildlife, recreation and water. The current method of evaluating site quality categorizes sites according to the productive potential of the site, expressed in cubic feet of growth per acre per year.

Of the 1.9 million acres of commercial forest land transferred to other uses between surveys, approximately 1.1 million acres were classified as medium sites (table 10). Commercial forest land was converted to other uses on 408,700 acres of good forest sites, 324,700 acres of poor forest sites, and 85,400 acres of excellent forest sites. Although the acreage of excellent commercial forest land does not seem large, 85,400 acres is almost one-quarter of the total excellent site acreage reported in 1959.

In general, the commercial forest land lost to other uses in the Ozark Units was of poorer site quality than that lost in the Prairie and River Units. Of the 85,400 acres of excellent commercial forest land lost between surveys, 63,400 acres (74 percent) occurred in the Northern Prairie Unit, 13,400 acres (16 percent) in the Riverbottom Unit and 8,600 acres (10 percent) in the Eastern Ozarks.

The 324,700 acres of poor quality commercial forest land lost to other uses between surveys were concentrated in the Ozark Units (302,400 acres), with small amounts of poor quality acreage also being lost in the Prairie Units.

Table 10.—*Area of commercial forest land converted to other uses between 1959 and 1972 by Survey Unit and site class, Missouri*

(In thousand acres)

Survey unit	All site classes	1959 site class			
		Excellent	Good	Medium	Poor
Eastern Ozarks	286.1	8.6	26.6	142.8	108.1
Southwestern Ozarks	557.1	—	94.2	371.0	91.9
Northwestern Ozarks	325.1	—	11.4	211.3	102.4
Southern Prairie	158.1	—	45.1	101.6	11.4
Northern Prairie	364.2	63.4	171.2	118.7	10.9
Riverborder	128.9	—	9.9	119.0	—
Mississippi Riverbottom	93.1	13.4	50.3	29.4	—
All units	1,912.6	85.4	408.7	1,093.8	324.7

WHICH FOREST TYPES HAVE BEEN MOST AFFECTED BY LAND-USE CHANGE?

Most forest types decreased in area between 1959 and 1972. The black-scarlet oak type underwent the largest decrease (fig. 3). This type covered 5.2 million acres in 1959; by 1972 the type area was 4.4 million acres, a decline of 15 percent. The elm-ash-cottonwood type lost the second largest area (623,000 acres), as the type acreage was cut almost in half. The largest percentage area lost was in the shortleaf pine type. Over 58 percent of the 1959 shortleaf pine area was converted to other types and uses by 1972. Other forest types showing a decline in area between surveys included eastern redcedar, shortleaf pine-oak, and oak-gum-cypress.

A decline in the areas of Missouri forest types may portend a decline in the volumes of commercial species available for harvest. Several tree species common to the forest types mentioned above are important commercial species. Black oak, a tree common to the black-scarlet oak type, is a major species used in the production of charcoal; 46 percent of the wood removed from Missouri's forests for charcoal production in 1969 was black oak[3]. Black walnut, an important veneer species, is a common associate of the black-scarlet oak type. Hickory, an associate of both the shortleaf pine type and eastern redcedar type, supplied over one-fifth of Missouri's veneer log volume in 1969 and was the major source of material for handle bolts.

If the volume of wood produced per acre remains unchanged while the number of acres available for production declines, the total volume of wood produced will decline. If it is desirable to maintain

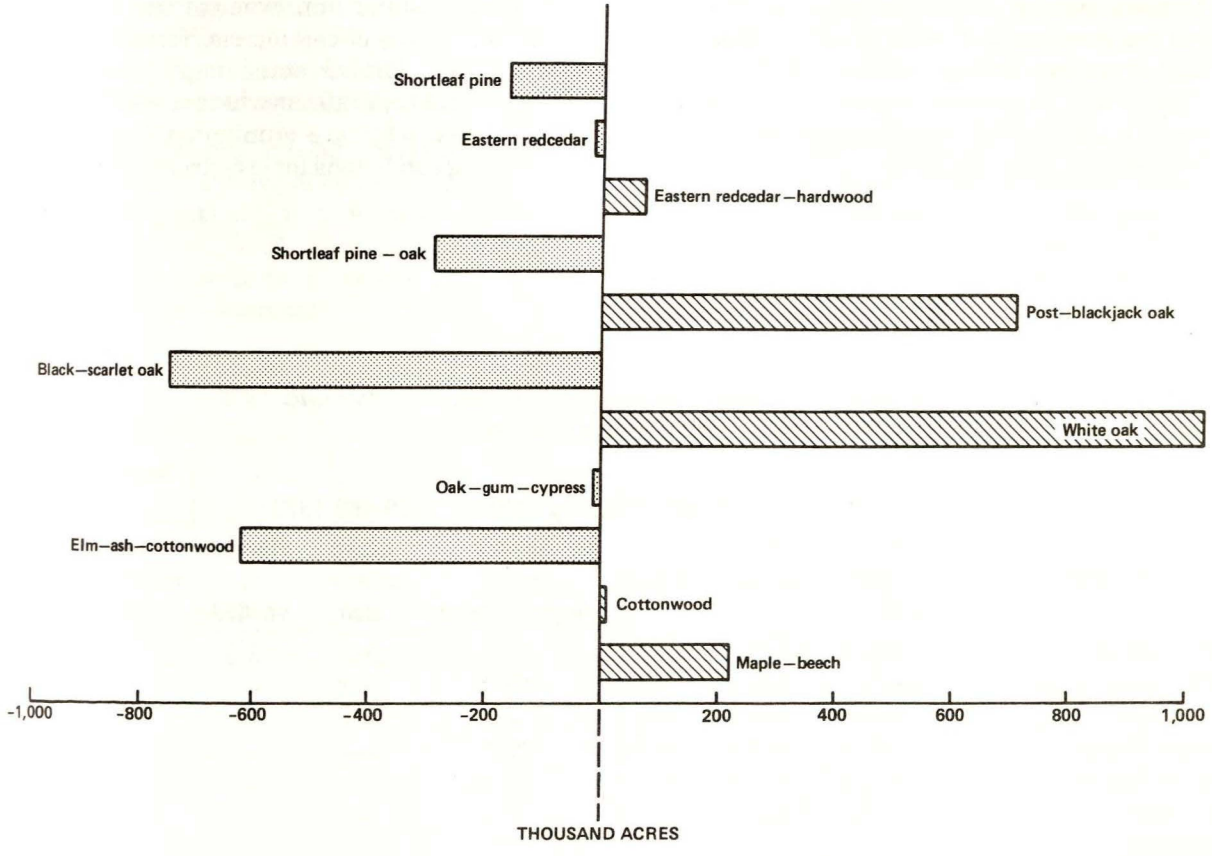


Figure 3.—*Net increases or decreases in commercial forest area by forest type, Missouri, 1959-1972.*

current levels of production, management must be intensified on the remaining acreage.

Several of Missouri's forest types increased in area between surveys. The area of white oak type increased 1.0 million acres between 1959 and 1972; post-blackjack oak increased 713,000 acres; maple-beech, 226,000 acres; eastern redcedar-hardwood, 74,000 acres, and cottonwood, 3,000 acres.

As with declining forest type areas, increases in the areas of certain forest types can give some indication of what changes may occur in the inventory volumes of commercial species. Increases in the area of a forest type may produce future increases in the volume of certain species of wood that may be made available to forest products industries. For example, the white oak species group, the principal group in the white oak type, composed over 35 percent of the total timber products output from roundwood volume removed from commercial forest land in 1969[3]. Increases in the area of the white oak type could increase the volumes of wood available for white oak products in the distant future. In 1969, cottonwood logs made up 45 percent of the pulpwood output in Missouri; increases in cottonwood acreage could mean a future increase in pulp material.

WHAT HAPPENED TO THE LANDS THAT REMAINED COMMERCIAL FOREST LAND BETWEEN 1959 AND 1972?

Although most (74 percent) of Missouri's commercial forests underwent little or no treatment between surveys, 2.7 million acres benefited from forest management practices (table 11).

Harvesting was the most common treatment in Missouri—it was the one treatment occurring in every region. Harvesting, as the term is used here, includes clearcutting, clearcutting with artificial regeneration, and harvesting practices where only part of a merchantable stand is removed. Over one-third of the total acreage harvested outside national forests was in the black-scarlet oak forest type. The post-blackjack oak and white oak forest types accounted for an additional 40 percent of the harvest acreage.

Timber stand improvement was carried out on 127,700 acres of commercial forest between 1959 and 1972. Timber stand improvement practices include: (1) operations where trees at least 5 inches in diameter are eliminated to provide better growing conditions for crop trees, (2) operations in

Table 11.—*Treatments occurring on commercial forest land between 1959 and 1972*
(In thousand acres)

Survey Unit	1959 Commercial forest	Treatments occurring between 1959 and 1972					Acreage changing land class	
		No change	Harvest	Timber stand improvements	Stand conversion	Planted or seeded	Non-commercial forest	Non-forest
Eastern Ozarks	4,259.4	2,911.7	971.1	40.9	35.7	13.9	70.8	215.3
Southwestern Ozarks	2,815.4	1,579.2	646.1	26.2	6.8	—	5.0	552.1
Northwestern Ozarks	2,146.3	1,588.1	233.1	—	—	—	58.9	266.2
Southern Prairie	742.3	444.9	101.2	38.1	—	—	31.1	127.0
Northern Prairie	1,666.5	1,007.9	271.9	22.5	—	—	—	364.2
Riverborder	1,975.9	1,592.1	254.9	—	—	—	—	128.9
Mississippi Riverbottom	212.5	83.1	34.9	—	—	1.4	—	93.1
Total 1959	13,818.3	9,207.0	2,513.2	127.7	42.5	15.3	165.8	1,746.8

young stands to free small trees from weeds, vines, or sod-growing grasses, (3) operations where less desirable species of trees with poor form are removed to liberate potential crop trees, and (4) pruning. Timber stand improvement was undertaken in the Eastern Ozarks, Southern Prairie, Southwestern Ozarks and Northern Prairie.

Stand conversion is the transformation of a stand of trees from one forest type to another through practices such as cutting, planting, or clearing. Over 42,500 acres of commercial forest land underwent stand conversion between 1959 and 1972. The Eastern Ozarks and the Southwestern Ozarks were the only Units affected by stand conversion. Over half of the acreage in other than national forest ownership undergoing stand conversion went to the black-scarlet oak type (16,100 acres). It is most likely that this acreage was previously classified as post-blackjack oak, which after cutting or clearing operations converted to the faster growing oak species in the black-scarlet oak type. An additional 15 percent (4,700 acres) of the stand conversion acreage went into white oak. The 2,100 acres of commercial forest converted to shortleaf-pine oak, were probably hardwood stands poisoned to encourage pine growth.

The planting or seeding of commercial tree species occurred on 15,300 acres of commercial forest land. The vast majority of this acreage was in the Eastern Ozarks, with a small amount occurring in the Mississippi Riverbottoms. Shortleaf pine was the predominant species planted.

SUMMARY

1. There is a shift in land use occurring in Missouri. The area of commercial forest land declined by 1.5 million acres (11 percent) between 1959 and 1972, while the areas of noncommercial forest land and nonforest land increased 106,300 acres and 1.2 million acres respectively.

2. The Southwestern Ozarks lost more commercial forest land than any other Survey Unit. The Mississippi Riverbottom Unit lost the largest percentage of its commercial forest area (41 percent). The Riverborder Unit was the only region to gain commercial forest land between surveys.

3. Over half of the commercial forest land converted to other uses was classified as medium quality forest land in 1959. Almost one-quarter of the excellent forest acreage reported in 1959 was converted to other uses by 1972.

4. The white oak forest type showed the greatest net increase in area. Nonstocked commercial forest land, black-scarlet oak and elm-ash-cottonwood forest types underwent the greatest decreases in area.

5. Of the land remaining commercial forest between surveys, most (74 percent) underwent little or no treatment between surveys. Harvesting was the most common treatment occurring in Missouri, followed by timber stand improvement, stand conversion and regeneration.

APPENDIX

ACCURACY OF SURVEY

Forest survey information is based on a sampling procedure designed to provide reliable statistics at the State and Survey Unit levels. A measure of reliability of these figures is given by sampling errors. These sampling errors may be interpreted as meaning that the chances are two out of three that the results for the sample differ, by no more than the amount indicated, from the results that would have been obtained if all trees in the State had been measured (a 100-percent inventory), using the same tree measurements.

For example, the estimated area of commercial forest land in the State in 1972, 12,364.7 thousand acres, has a sampling error of ±0.78 percent (±96.4 thousand acres). The chances are two out of three, then, that the commercial forest area falls between 12,268.3 and 12,461.1 thousand acres (12,364.7±96.4).

Item	State totals	Sampling erro
		(Percent)
Growing stock:		
Volume	6,001.5 MM cubic feet	1.54
Growth	177.3 MM cubic feet	2.19
Removals	167.7 MM cubic feet	4.18
Sawtimber:		
Volume	15,054.9 MM board feet	2.17
Growth	363.5 MM board feet	3.01
Removals	542.0 MM board feet	7.58
Commercial forest land	12,364.7 M acres	0.78

As survey data are broken down into uni smaller than State or Survey Unit totals, the sar pling error increases. The smaller the breakdow the larger the sampling error. For example, th sampling error for area of commercial forest lar in a particular county is much higher than that fo total commercial area in the State. An approxima tion of the increasing sampling error can be ob tained from table 12, which shows the samplin errors associated with estimates smaller tha totals in Missouri.

[4]*At the 68-percent probability level.*

Table 12.—*Sampling errors*[1] *for estimates smaller than State totals of volume, net growth and removals, and area of commercial forest land in Missouri, 1972*

Sampling error	Commercial forest	Growing stock Volume	Growing stock Growth	Growing stock Removals	Sawtimber Volume	Sawtimber Growth	Sawtimber Removal
Percent	*Thousand*	*Million cubic feet*			*[2]Million board feet*		
1	7,467.1	14,212.3	853.6	2,930.1	71,068.3	3,297.5	31,142.3
2	1,866.8	3,553.2	213.4	732.5	17,767.1	824.4	7,785.8
3	829.7	1,579.2	94.8	325.6	7,896.5	366.4	3,460.3
4	466.7	888.3	53.3	183.1	4,441.8	206.1	1,946.4
5	298.7	568.5	34.1	117.2	2,842.7	131.9	1,245.7
10	74.7	142.1	8.5	29.3	710.7	33.0	311.4
15	33.2	63.2	3.8	13.0	315.9	14.7	138.4
20	18.7	35.5	2.1	7.3	177.7	8.2	77.9
25	11.9	22.7	1.4	4.7	113.7	5.3	49.8
50	3.0	5.7	0.3	1.2	28.4	1.3	12.5
100	0.7	1.4	0.1	0.3	7.1	0.3	3.1

[1]At the 68-percent probability level.
[2]International ¼-inch rule.

SURVEY PROCEDURE

Data used in this report were gathered from permanent sample plots (each of which contained one variable-radius plot with basal area factor five) established during the 1959 survey. These 1,640 points were remeasured by superimposing a 10-point variable-radius plots (basal area factor 37.5) over the existing plot in addition to remeasuring the basal area factor five plot.

DEFINITION OF TERMS

Land-Use Classes

Gross area.—The entire area of land and water as determined by the Bureau of Census, 1960.

Land area.—The area of dry land and land temporarily or partially covered by water such as marshes, swamps, flood plains, streams, sloughs, and estuaries. Canals less than ⅛-mile wide, and lakes, reservoirs, and ponds smaller than 40 acres are included as land area. These figures are from the Bureau of Census, 1960.

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest use. Includes afforested areas. The minimum forest area classified was 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, and clearings in forest areas were classed as forest if less than 120 feet in width.

Commercial forest land.—Forest land that is producing or is capable of producing crops of industrial wood and that is not withdrawn from timber utilization by statute or administrative regulation. This includes areas suitable for management to grow crops of industrial wood generally of a site quality capable of producing in excess of 20 cubic feet per acre of annual growth. This includes both inaccessible and inoperable areas.

Noncommercial forest land.—(a) Unproductive—forest land incapable of yielding crops of industrial wood because of adverse site conditions, (b) Productive-reserved—forest land withdrawn from commercial timber use through statute or administrative regulation, or exclusively used for Christmas tree production.

Nonforest land.—Land that has never supported forests, and land formerly forested where forest use is precluded by development for nonforest uses, such as cropland, improved pasture, residential areas, and city parks. Also includes improved roads and adjoining rights-of-way, powerline clearings, and certain areas of water classified by the Bureau of Census as land. Unimproved roads, streams, canals, and nonforest strips in forest areas must be more than 120 feet wide, and clearings in forested areas must be more than 1 acre in size, to qualify as nonforest land.

Tree Classes

All live trees.—Growing-stock, rough and rotten trees 1 inch d.b.h. and larger.

Growing-stock trees.—All live trees of commercial species except rough and rotten trees.

Sawtimber trees.—Growing-stock trees of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs, each 8 feet or longer. At least 33 percent of the gross volume of the tree must be sound wood. Softwoods must be at least 9.0 inches d.b.h. and hardwoods at least 11.0 inches.

Rotten trees.—Live trees (any size) of commercial species that do not contain a merchantable 12-foot saw log or two noncontiguous 8-foot or longer saw logs, now or prospectively, because of rot (that is, when more than 50 percent of the cull volume of the tree is rotten).

Rough trees.—Live trees that do not contain at least one merchantable 12-foot saw log or two noncontiguous 8-foot or longer saw logs, now or prospectively, because of roughness and poor form, as well as all live noncommercial species.

Stocking

The degree of utilization of land by trees as measured in terms of basal area and/or number of trees in a stand compared to the basal area and/or number of trees required to utilize fully the growth potential of the land.

A stocking percent of 100 indicates full utilization of the site and is equivalent to 80 square feet of basal area per acre in trees 5 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the percent number of trees is sufficient to produce 80 square feet of basal area per acre when the trees do reach 5 inches d.b.h.

Forest Types

A classification of forest land based upon the species forming a plurality of live-tree stocking. Major forest types in Missouri are:

Shortleaf pine.–Forests in which shortleaf pine comprises a plurality of the stocking. (Common associates include oak, hickory and gum.)

Eastern redcedar.—Forests in which eastern redcedar comprises a plurality of the stocking. (Common associates include oak and hickory.)

Eastern redcedar-hardwood.—Forests in which hardwoods (usually upland oaks) comprise a plurality of the stocking but in which eastern redcedar comprises 25 to 50 percent of the stocking. (Common associates include gum, hickory, and yellow-poplar.)

Shortleaf pine-oak.—Forests in which upland oaks comprise a plurality of the stocking, but in which shortleaf pine comprises 25 to 50 percent of the stocking.

Post-blackjack oak.—Forests in which post oak or blackjack oak, singly or in combination, comprises a plurality of the stocking except where shortleaf pine or redcedar comprises 25 to 50 percent.

Black-scarlet oak.—Forests in which upland oaks or hickory, singly or in combination, comprises a plurality of the stocking except where shortleaf pine or redcedar comprises 25 to 50 percent, or where white oak or post and blackjack oak comprise a plurality. (Common associates include yellow-poplar, elm, maple, and black walnut.)

White oak.—Forests in which white oak and other white oak species, singly or in combination, comprise a plurality of the stocking except where shortleaf pine or redcedar comprises 25 to 50 percent.

Oak-gum-cypress.—Bottomland forests in which bottomland oaks such as pin, swamp white, and shingle oaks, along with tupelo, blackgum, sweetgum, and cypress, singly or in combination, comprise a plurality of the stocking. (Common associates include cottonwood, willow, ash, elm, hackberry, and maple.)

Elm-ash-cottonwood.—Forests in which elm, ash, or cottonwood, singly or in combination, comprises a plurality of the stocking. (Common associates include willow, sycamore, beech, and maple.)

Cottonwood.—Forests in which cottonwood comprises a plurality of the stocking.

Maple-beech.—Forests in which hard maple or beech, singly or in combination, comprises a plurality of the stocking. (Common associates include elm and basswood.)

Timber Volume

Volume of growing stock.—The volume of sound wood in the bole of growing-stock trees 5.0 inches d.b.h. and over, from a 1-foot stump to a minimum of 4.0-inch top diameter outside bark, or to the point where the central stem breaks into limbs. Growing-stock volumes are shown in cubic feet.

Timber Removals

Timber removals from growing stock.—The volume of sound wood in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other removals. Roundwood products are logs, bolts, and other round sections cut and used from trees. Logging residues are the unused portions of cut trees plus unused trees killed by logging. Other removals are growing-stock trees removed but not utilized for products, or trees left standing but "removed" from the commercial forest land classification by land use change—examples are removals from cultural operations such as timber stand improvement work, land clearing, and changes in land use.

Timber products output.—All timber products cut from roundwood, and byproducts of wood manufacturing plants. Roundwood products include logs, bolts, or other round sections cut from growing-stock trees, cull trees, salvable dead trees, trees on nonforest land, noncommercial species, sapling-size trees, and limbwood. Byproducts from primary manufacturing plants include slabs, edgings, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and screenings of pulpmills that are used as pulpwood chips or other products.

Table 13.— *Changes in the commercial forest land base between 1959 and 1972, by Survey Unit, Missouri*
(In thousand acres)

	State Total	Eastern Ozarks	Southwestern Ozarks	Northwestern Ozarks	Southern Prairie	Northern Prairie	River-border	Mississippi Riverbottoms
1959 Commercial forest area	13,818.3	4,259.4	2,815.4	2,146.3	742.3	1,666.5	1,975.9	212.5
ADDITIONS TO THE COMMERCIAL FOREST LAND BASE, BY LAND CLASS								
Noncommerical forest								
Productive - reserved	—	—	—	—	—	—	—	—
Unproductive	67.8	16.3	10.3	41.2	—	—	—	—
Nonforest	391.2	94.4	42.8	57.6	36.9	17.0	137.5	5.0
Subtotal	459.0	110.7	53.1	98.8	36.9	17.0	137.5	5.0
REDUCTIONS IN THE COMMERCIAL FOREST LAND BASE, BY LAND CLASS								
Noncommercial forest								
Productive - reserved	165.8	70.8	5.0	58.9	31.1	—	—	—
Unproductive	—	--	—	—	—	—	—	—
Nonforest								
Pasture (other)	1,165.9	111.6	438.9	193.7	101.7	222.5	89.8	7.7
Cropland	230.0	41.4	10.6	—	25.3	61.9	9.7	81.1
Pastureland (herbicides)	166.2	6.6	74.4	66.7	—	18.5	—	—
Rights-of-way	84.8	24.0	20.5	—	—	30.5	9.8	—
Urban	36.4	15.9	5.1	—	—	15.4	—	—
Recreation	33.1	7.9	—	—	—	15.4	9.8	—
Other	30.4	7.9	2.6	5.8	—	—	9.8	4.3
Subtotal	1,912.6	286.1	557.1	325.1	158.1	364.2	128.9	93.1
1972 Commercial forest area	12,364.7	4,084.0	2,311.4	1,920.0	621.1	1,319.3	1,984.5	124.4

Table 14.— *Changes in land use, Missouri, all units, 1959-1972*
(In thousand acres)

		1972 Land class				
		Forest				
1959 Land class		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	13,818.3	11,905.7	165.8	—	1,746.8	—
Productive-reserved	90.3	—	90.3	—	—	—
Unproductive	357.8	67.8	—	269.3	20.7	—
Nonforest	30,038.2	391.2	—	29.0	29,502.7	115.3
Total land	44,304.6					
1972 Total land	44,189.3	12,364.7	256.1	298.3	31,270.2	

[1] Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

Table 15.— *Changes in land use, Missouri, Eastern Ozarks, 1959-1972*
(In thousand acres)

1959 Land class		1972 Land class				
		Forest				
		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	4,259.4	3,973.3	70.8	—	215.3	—
Productive-reserved	26.5	—	26.5	—	—	—
Unproductive	71.9	16.3	—	55.6	—	—
Nonforest	1,792.0	94.4	—	7.7	1,703.0	−13.1
Total land	6,149.8					
1972 Total land	6,162.9	4,084.0	97.3	63.3	1,918.3	

[1]Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

Table 16.— *Changes in land use, Missouri, Southwestern Ozarks, 1959-1972*
(In thousand acres)

1959 Land class		1972 Land class				
		Forest				
		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	2,815.4	2,258.3	5.0	—	552.1	—
Productive-reserved	17.6	—	17.6	—	—	—
Unproductive	121.2	10.3	—	103.7	7.2	—
Nonforest	2,573.5	42.8	—	5.6	2,437.7	87.4
Total land	5,527.7					
1972 Total land	5,440.3	2,311.4	22.6	109.3	2,997.0	

[1]Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

Table 17.— *Changes in land use, Missouri, Northwestern Ozarks, 1959-1972*
(In thousand acres)

1959 Land class		1972 Land class				
		Forest				
		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	2,146.3	1,821.2	58.9	—	266.2	—
Productive-reserved	14.7	—	14.7	—	—	—
Unproductive	116.6	41.2	—	61.9	13.5	—
Nonforest	2,780.9	57.6	—	15.5	2,678.8	29.0
Total land	5,058.5					
1972 Total land	5,029.5	1,920.0	73.6	77.4	2,958.5	

[1]Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

Table 18.— *Changes in land use, Missouri, Southern Prairie, 1959-1972*
(In thousand acres)

1959 Land class		1972 Land class				
		Forest				
		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	742.3	584.2	31.1	—	127.0	—
Productive-reserved	3.7	—	3.7	—	—	—
Unproductive	4.5	—	—	4.5	—	—
Nonforest	5,786.5	36.9	—	—	5,745.4	4.2
Total land	6,537.0					
1972 Total land	6,532.8	621.1	34.8	4.5	5,872.4	

[1]Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

Table 19.— *Changes in land use, Missouri, Northern Prairie, 1959-1972*
(In thousand acres)

1959 Land class		1972 Land class				
		Forest				
		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	1,666.5	1,302.3	—	—	364.2	—
Productive-reserved	11.7	—	11.7	—	—	—
Unproductive	11.4	—	—	11.4	—	—
Nonforest	11,330.5	17.0	—	—	11,308.9	4.6
Total land	13,020.1					
1972 Total land	13,015.5	1,319.3	11.7	11.4	11,673.1	

[1]Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

Table 20.— *Changes in land use, Missouri, Riverborder, 1959-1972*
(In thousand acres)

1959 Land class		1972 Land class				
		Forest				
		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	1,975.9	1,847.0	—	—	128.9	—
Productive-reserved	15.2	—	15.2	—	—	—
Unproductive	32.2	—	—	32.2	—	—
Nonforest	3,827.6	137.5	—	0.2	3,687.6	2.3
Total land	5,850.9					
1972 Total land	5,848.6	1,984.5	15.2	32.4	3,816.5	

[1]Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

Table 21.— *Changes in land use, Missouri, Mississippi Riverbottoms, 1959-1972*
(In thousand acres)

1959 Land class		1972 Land class				
		Forest				
		Commercial	Productive-reserved	Unproductive	Nonforest	Area Adjustment[1]
Forest						
Commercial	212.5	119.4	—	—	93.1	—
Productive-reserved	0.9	—	0.9	—	—	—
Unproductive	0.0	—	—	—	—	—
Nonforest	1,947.2	5.0	—	—	1,941.3	0.9
Total land	2,160.6				—	
1972 Total land	2,159.7	124.4	0.9	0.0	2,034.4	

[1]Area adjustment indicates changes in Bureau of Census land area estimates between surveys. It may include land converted to water.

☆ U.S. Government Printing Office: 1979—667-820/80 Region No. 6

Jakes, Pamela J., John S. Spencer, Jr., and Burton L. Essex.
1978. Land-use change in Missouri, 1959-1972. U.S. Dep. Agric. For. Serv., Resour. Bull. NC-40, 19 p. North Cent. For. Exp. Stn., St. Paul, Minnesota.

Missouri's third Forest Survey showed an 11 percent decline in commercial forest area between 1959 and 1972. Most of this land was converted to nonforest uses, primarily pasture. Of the land that remained classified as commercial forest, 75 percent underwent little or no treatment between surveys.

OXFORD: 913/914(778). KEY WORDS: area, land conversion, forest treatments, forest survey.

Jakes, Pamela J., John S. Spencer, Jr., and Burton L. Essex.
1978. Land-use change in Missouri, 1959-1972. U.S. Dep. Agric. For. Serv., Resour. Bull. NC-40, 19 p. North Cent. For. Exp. Stn., St. Paul, Minnesota.

Missouri's third Forest Survey showed an 11 percent decline in commercial forest area between 1959 and 1972. Most of this land was converted to nonforest uses, primarily pasture. Of the land that remained classified as commercial forest, 75 percent underwent little or no treatment between surveys.

OXFORD: 913/914(778). KEY WORDS: area, land conversion, forest treatments, forest survey.

Birds, animals and flowers are dying to tell us...no pollution, please!